

OREGON WAVE ENERGY TRUST UTILITY MARKET INITIATIVE

TASK 4.1: INTERCONNECTION GUIDELINES



www.oregonwave.org



www.peventuresllc.com

The Utility Market Initiative was prepared by *Pacific Energy Ventures* on behalf of the Oregon Wave Energy Trust.

DECEMBER 2009

This work was funded by the Oregon Wave Energy Trust (OWET).

OWET was funded in part with Oregon State Lottery Funds administered by the Oregon Business Development Department. It is one of six Oregon Innovation Council initiatives supporting job creation and long term economic growth.

This Utility Market Initiative was prepared by Pacific Energy Ventures on behalf of the Oregon Wave Energy Trust.

For information about this project, please contact Justin Klure at Pacific Energy Ventures:

Phone: (503) 475-2999

Email: jklure@peventuresllc.com

About Oregon Wave Energy Trust

The Oregon Wave Energy Trust – (OWET) - with members from fishing and environmental groups, industry and government - is a nonprofit public-private partnership funded by the Oregon Innovation Council in 2007. Its mission is to serve as a connector for all stakeholders involved in wave energy project development - from research and development to early stage community engagement and final deployment and energy generation - positioning Oregon as the North America leader in this nascent industry and delivering its full economic and environmental potential for the state. OWET's goal is to have ocean wave energy producing 2 megawatts of power - enough to power about 800 homes - by 2010 and 500 megawatts of power by 2025.

Interconnection Guidelines

Purpose

The interconnection process requires early coordination with the utility to which the resource will be connected. The process is specific to the utility but information requirements and timelines for evaluation tend to be the same. Outlined below are summary documents developed under this project and websites to guide early action on interconnection.

Definitions

- **Interconnection** - electrical connection of a generator(s) to a transmission or distribution systems
- **Integration** - the electrical connection of a generator(s) into a transmission or distribution system that is not owned by the Balancing Authority. Example: the generator is electrically connected to Douglas Electric Coop which resides in BPA's Balancing Authority.

Resource Documents

If connecting to the **Bonneville Power Administration** System see:

- BPA Generation Interconnection Process Overview (*next page*)
- http://www.transmission.bpa.gov/business/generation_interconnection/

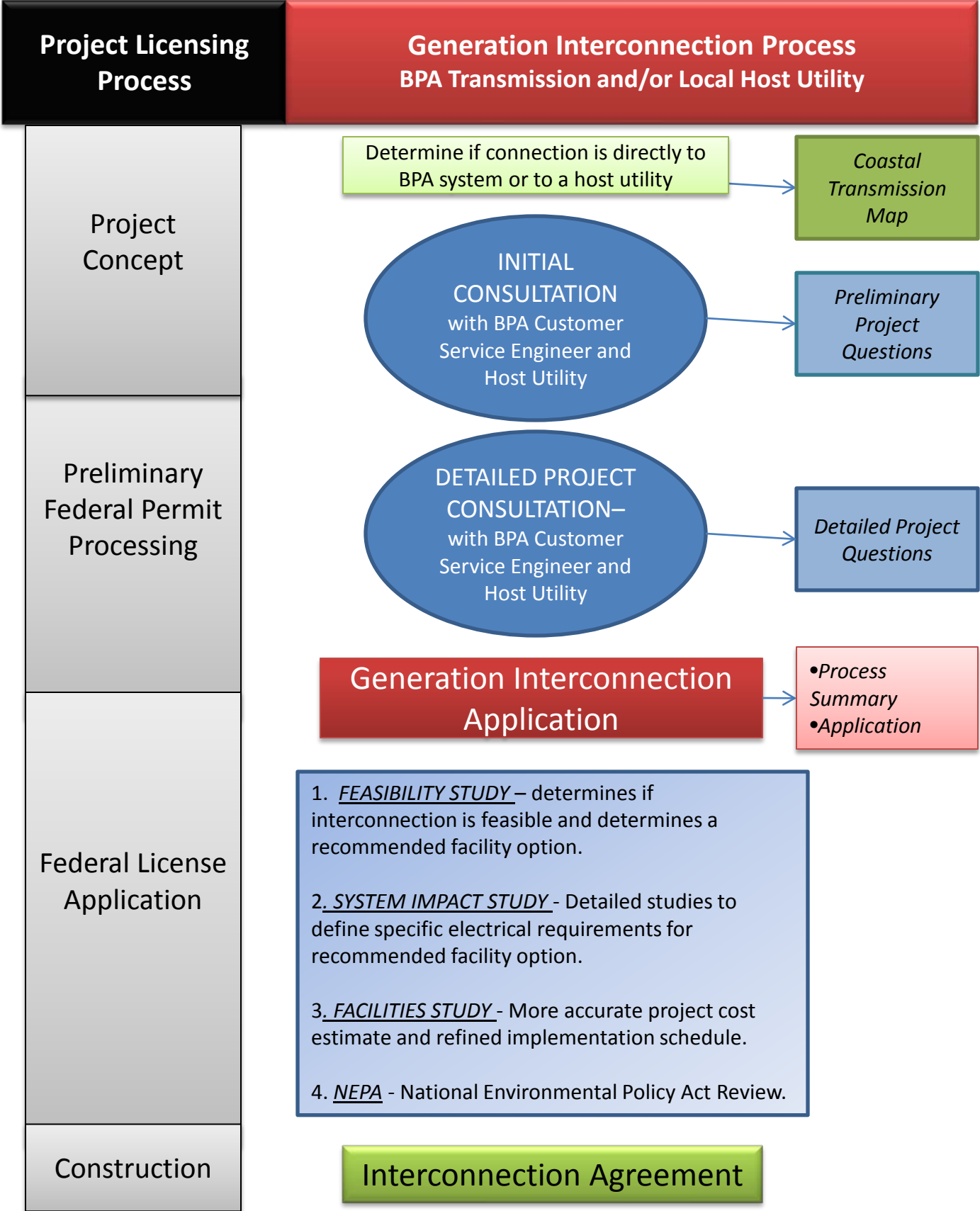
If connecting to **Tillamook PUD, Central Lincoln PUD, Douglas Electric Coop, or Coos Curry Electric Coop** see

- BPA Generation Interconnection Process Overview (*next page*)
- http://www.transmission.bpa.gov/business/generation_interconnection/

If connecting to the **PacifiCorp** System see:

- A Brief Overview of Interconnection Rules in Oregon (*attached*)
- <http://www.pacificpower.net/Article/Article71371.html>

BPA Transmission Interconnection Process Overview*



*BPA Transmission Service is secured through a separate process



BPA Transmission Facilities in Western Oregon

BPA Transmission Facilities

- 115-kV
- 230 - 345-kV
- 500-kV
- Greater than 500-kV
- ▲ BPA Substation

Foreign Owned Substations

- Coos-Curry Electric Coop
- Central Lincoln PUD
- Portland General Electric
- PacificCorp
- Tillamook PUD
- Western Oregon Electric Coop
- Consumer's Power, Inc.

0 10 20 30 40
Miles

N
Map Update: 11/24/09
Map date: 11/5/09

BPA Generation Interconnection Process Overview

Preliminary Project Questions

1. What type of generation is being proposed (wind, solar, hydro, geothermal, wave, tidal, diesel engine, gas engine, gas turbine, etc)?
2. What is the total amount of generation (Unit size and number of units)?
3. What type of Generator (Synchronous, Induction, Inverter, etc.)?
4. Where is the generation interconnection point and name of local serving electric utility?
 - a) What is the voltage level of the existing transmission or distribution system at point of generation interconnection?
 - b) Identify the specific location of the generation interconnection to the existing transmission or distribution system (one line diagram or sketch including information on transformer location, impedance and connections (delta-wye, etc.) including the generation step-up transformer between the generation and the BPA transmission system).
 - c) Where is the point of interconnection with the BPA system (Point of Delivery or interconnection point to another electric utility or load control area)?
5. What is the amount of radial load served by the transmission and distribution system at the point of generation interconnection?
6. Are there existing generators (number, size and location) connected to the transmission and distribution system served from the same point of interconnection with the BPA transmission system?
7. What is the proposed "on-line" date for the generation?
8. Should this generation be considered a long-term or a temporary installation (If temporary, when will the generation be removed)?
9. Will transmission Ancillary Services be needed across BPA's transmission system?

BPA Generation Interconnection Process Overview

Detailed Project Questions

Single Generator Unit

1. What type of generator (Synchronous, Induction, Inverter)?
2. Is it a DC generator? If yes, what type of DC to AC inverter (conversion of DC to AC)
 - a) Adequate harmonic filtering
 - b) Inverter failure protection
3. What is the output voltage level?
4. Is the generator output three-phase or single-phase?
5. What is the method/equipment for synchronization with grid?
6. What is the method for voltage transformation?
7. Where will the transformer be located:
 - a) Integral with generator unit
 - b) Separate sea-floor or river-bottom
 - c) Floating
 - d) On-shore
8. What is the voltage for lines(s) to shoreline interface?
9. What type of generator governor system/equipment will be used?
10. Will there be Generator on-board controls, protective relays, or power output circuit breakers?
11. What type of Generator telemetry/communications/SCADA is planned?
12. What is the communication method for remote alarm outputs?
13. Is there battery backup for relay and control systems?
14. How will the unit be isolated for required maintenance?

Multiple Generator Units

1. Will the units have common interconnection points?
2. Will the units have separate or common output voltage transformation?

Shoreline Interface

1. What is the distance from generator to shore-line interface?
2. What is the voltage rating for the shoreline interface?
3. What is the voltage rating vs. ampacity of the shoreline interface?
4. What type of submarine cable conductor will be used?
5. What is the conductor size versus the loading/generation block size?
6. Will the interface be double-ended/looped or single-ended/radial?
7. How will line maintenance be provided without generator shutdown?
8. What type of voltage drop or loss conditions are expected?
9. Will the shoreline interface use a simple conductor inter-connect?
 - a) Underground vault and splices - continued underground
 - b) Pole-top cable potheads - continued overhead open-wire

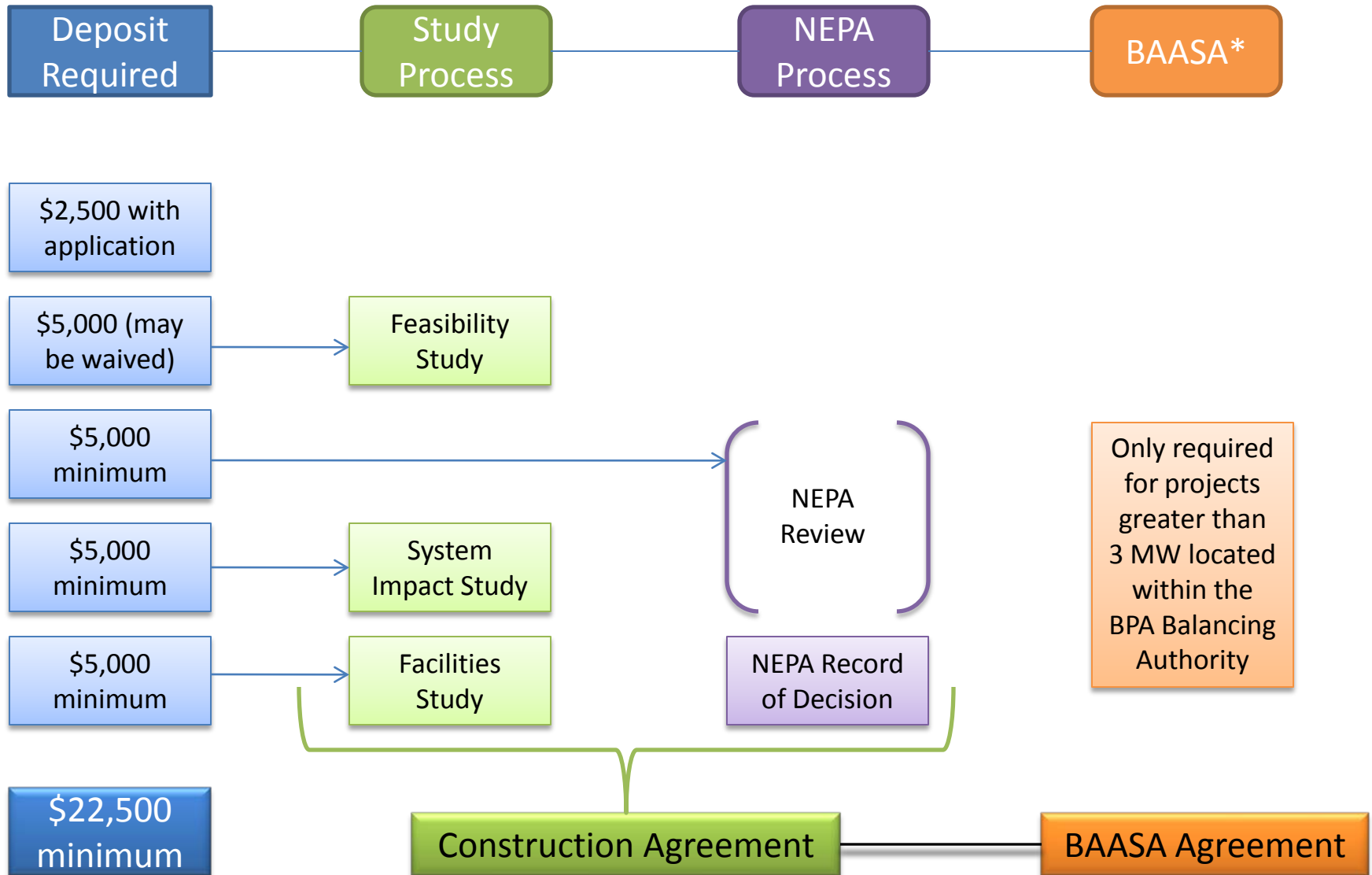
- c) Pole-top cable potheads - continued overhead space cable
- d) Disconnecting means at shoreline interface
- 10. Will the shoreline Interface use a circuit breaker or fuse?
 - a) Pole-mounted fused disconnect
 - b) Pole-mounted 3-phase automatic circuit recloser
 - c) Pad-mounted fused disconnect
 - d) Pad-mounted 3-phase automatic circuit recloser
 - e) Remote indication of breaker/trip fuse
- 11. What type of step-up transformer will be used for the shoreline interface?
 - a) Simple pad-mount transformer with fuse protection
 - b) Existing substation near shoreline interface
 - c) New substation, complete with transformers
 - d) New substation tie to grid primary voltage line

Shoreline interface to Grid/Subgrid interconnection

- 1. Is there an existing powerline already serving loads?
 - a) How to prevent undesirable interaction?
 - b) Is new relaying/protection for existing loads needed?
- 2. Is a new powerline(s) dedicated for the generation needed?
 - a) Is radial or double-ended loop feed needed?
 - b) Are line switching provisions for no-outage maintenance needed?
 - c) Would it be standard overhead construction? Or would underground cable be more appropriate?
- 3. Will the interconnection use an existing substation with upgrades and additions or will it require a new substation, complete with transformers?
- 4. What requirements will be needed at the substation?
 - a) Transformer and line protection
 - b) Required protective relaying
 - c) Remote indication of outages
 - d) Real-time data telemetry
 - e) kWh metering with remote query for data
 - f) SCADA control and remote indication
- 5. What type of interconnection line tap requirements are needed?

BPA Small Generation Interconnection Application Process

(for projects ≤ 20 MW)



*Balancing Authority Area Service Agreement
between BPA and the Interconnection Customer



Report for:
Oregon Wave Energy Trust – Utility Market Initiative
A Brief Overview of Interconnection Rules in Oregon

16 November 2009

Authored by:
Diane Broad, P.E., Sr. Consultant
and Kalin Lee, Associate Consultant
Ecofys US

A Brief Overview of Interconnection Rules in Oregon

The Oregon Public Utility Commission (OPUC) adopted the state's small generator interconnection rule, AR 521, in June 2009 and the rule became effective on August 26, 2009. Since only investor-owned utilities in Oregon are regulated by the OPUC, they alone are subject to this rule. Of the three investor-owned utilities in Oregon, only PacifiCorp has any transmission or distribution along the Oregon coast. The state's municipal utilities, electric cooperatives, and people's utility districts, as well as the Bonneville Power Administration (BPA) generally follow the FERC rules for interconnection, which are discussed below.

AR 521 applies only to the interconnection of small generator facilities of 10 MW or less to the transmission or distribution system of one of the investor-owned utilities governed by the OPUC. If the output of the small generator is wheeled through the investor-owned utility's system to another system, AR 521 does not apply. In those situations the interconnection is governed by FERC Order 2006, Small Generator Interconnect Procedures (SGIP). In general, AR 521 does not apply if the project is FERC jurisdictional, and does not apply to net metering facilities. The interconnection rules under AR 521 are not retroactive, although a project which had previously submitted an interconnection request but not yet executed an interconnection agreement can re-apply for consideration under the new rules and not lose its queue position.

The underlying technical basis for AR 521 is the IEEE Standard 1547 (2003), Standard for Interconnecting Distributed Resources with Electric Power Systems. This standard has been developed to address technical issues with interconnection of projects 10 MW and smaller. There is a full family of daughter standards under development for IEEE 1547, including 1547.1 (2005), Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems. AR 521 dictates that the interconnecting utility must use IEEE 1547 and 1547.1 to evaluate small generator interconnection applications.

The interconnection process set out in AR 521 is tiered by size and other characteristics. The rule covers construction, operation and maintenance, cost responsibility, insurance, record-keeping and reporting, metering and monitoring, temporary disconnection, and arbitration of disputes.

The application process is tiered by project size:

Tier 1: 25 kW or less and not connected to transmission.

Tier 2: 2 MW or less and not connected to transmission.

Tier 3: 10 MW or less and must not export power beyond point of interconnection.

Tier 4: 10 MW or less and does not qualify or failed to meet tier 1, 2, or 3 requirements.

Each tier has different restrictions for design, capacity, current imbalance, fault current, wiring configurations, and other specifications. If multiple generators are connected at one point of interconnection, the combined nameplate capacity is used to evaluate the application.

Tier 1:

Only a simplified contract is required for Tier 1, 25 kW lab-tested, inverter-based generators. There is a \$100 maximum application fee. The interconnecting utility has 10 days from the date of filing to notify the applicant that its application is complete or incomplete, and 15 days to notify the applicant whether the facility meets approval criteria.

Tier 2:

A Tier 2 generator, for 2 MW or less, also requires that there is no connection to a transmission line. The interconnection must be to a radial distribution circuit or to the only customer on a spot network. A Tier 2 project must have a lab or field-tested interconnection. However, field-tested interconnections also require Tier 4 documentation from a previously executed project. There is a \$500 maximum application fee. The interconnecting utility has 10 days from the date of filing to notify the applicant that its application is complete or incomplete, and 20 days to notify the applicant whether the facility meets approval criteria.

Tier 3:

A Tier 3 generator, for 10 MW or less and no power export, must not be connected to a transmission line, but instead must be interconnected to a radial distribution circuit or to the only customer on spot network. In addition, the generator must have low forward power relays or other protection to prevent power flow onto the area network. There is a \$1000 maximum application fee. The interconnecting utility has 10 days from the date of filing to notify the applicant that its application is complete or incomplete, and 15 days to notify the applicant whether the facility meets approval criteria.

Tier 4:

A Tier 4 generator produces 10 MW or less, but will not qualify for Tiers 1, 2, or 3. There is a \$1000 maximum application fee. A scoping meeting is required for this study-based process. The scoping meeting determines whether the utility should perform a feasibility study, a system-impact study, or a facility study; however, none is required. If no studies are deemed necessary, the interconnecting utility may proceed to offering an interconnection agreement.

For pilot-scale projects connecting to PacifiCorp distribution or transmission the state interconnection rule, AR 521, applies. If the project is less than 20 MW and interconnecting to BPA, and in circumstances where the output of the small generator is wheeled through an investor-owned utility's system to another system, the FERC SGIP applies. The SGIP is similar to AR 521 in several ways. For example, each is tiered according to generator size; AR 521 has four tiers while the SGIP has three. In the SGIP, the first-tier projects cannot exceed 10 kW, and the second-tier projects cannot exceed 2 MW. Both of these tiers allow for a more stream-lined "fast track" interconnection process than the third-tier projects, which can be any size between 2 MW and 20 MW. Third-tier projects are subject to a study process similar to a Tier 4 project under AR 521. Despite their similarities, the SGIP allows for some higher fees and longer timelines for the various steps of the interconnection process.

Most of the electric co-ops, muni's and PUD's in the Northwest also follow the FERC interconnection rules and procedures, although they are not required to do so. This means that some publicly-owned utilities may have application fees, study fees, and/or study timelines that

exceed what is allowed under the FERC rules. Some publicly-owned utilities that receive their power exclusively through BPA contracts may have personnel at BPA perform any necessary studies and handle the interconnection application entirely. Others have the capability within their own staff to process the applications, or hire external consultants who perform the studies to the standards of the utility.

Wave energy projects, like other generators, will need to negotiate for the best technical and operational configuration for the interconnection. Figure 1 below illustrates the basic layout of a typical utility interconnection, and identifies common points of study and negotiation.

- location of the POI (Point of Interconnection)
- identification of interconnection facilities to be owned by the project, and those to be owned by the utility
- necessity for disconnect switches, circuit breakers and/or reclosers, and other protection and control devices to ensure safe operation of the generator

For some wave energy conversion technologies, the generator, power cable and power conditioner are all at sea. For other technologies, some of these components are on shore. In general, it is assumed that the interconnecting utility will only accept a POI on shore.

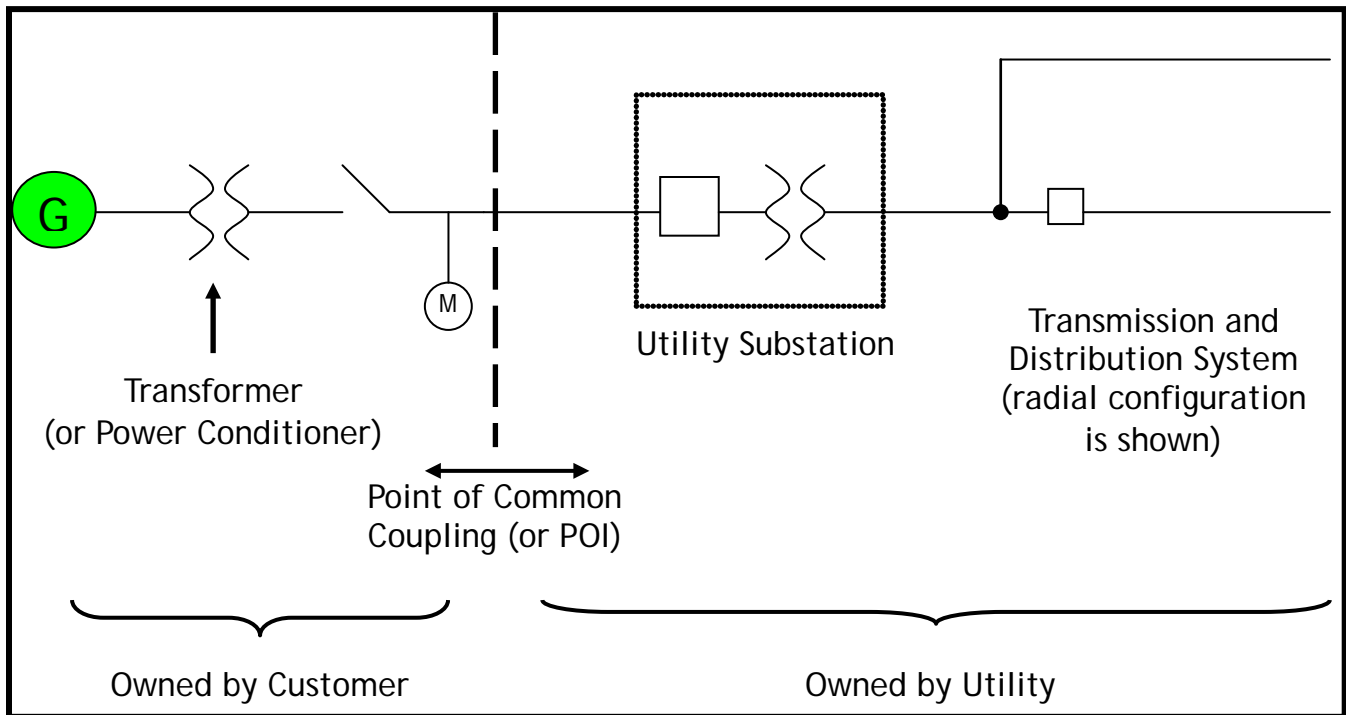


Figure 1. The Building Blocks of Interconnection

When wave energy technology is more fully matured and projects are built with output of 20 MW or greater, the FERC Order 2003, Large Generator Interconnect Procedures (LGIP) will apply. The LGIP does not have any tiers and requires studies for all projects. The LGIP is more complex, and the time lines for interconnection are longer than under the SGIP. A scoping meeting is required between the developer and the utility at the outset of the interconnection process, and feasibility studies, system-impact studies, and facilities studies may be required. Each of these studies is likely to be more complex and costly than those performed under the SGIP. The total interconnection process for a large generator facility can take from 18 months to 2 years to complete, and will typically cost over \$100,000.

Conclusion

Wave energy projects will encounter varying levels of ease with interconnection, depending on many factors, possibly including converter technology, the interconnecting utility, the POI, and potential need for upgrades to the utility's electric system. The following points should be understood by all parties involved in interconnecting a wave energy project to the electric grid.

- Interconnection is a complex, highly regulated process
- Utilities have constraints: long interconnection queues, limited engineering staff, evolving regulations
- Applicants have constraints: minimizing cost and time to interconnect and associated risks (e.g., maintaining investor confidence, PTC expiration), uncertainty about generating equipment, inter-related processes of project financing and utility agreements
- Access to the utility grid for renewable projects is viewed as a top priority of Federal regulators, US DOE, the Oregon PUC and industry